Space Weather Technical Forecast

Issued on Friday, 10 February 2023 at 13:27 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: M-flares (R1/R2 Radio Blackouts) expected.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate activity was observed, with six M-flares in the last 24 hours, some of which were double peaked. The largest flare was an M3.7 flare at 10/0303 UTC from AR3213. Further M-flares are expected, with a slight chance of X-flares. These most likely from AR3217 or AR3213, the latter of which has been the most active region in recent hours. This spot persists as a moderately sized region, with a recent reduction in areal extent mainly from it's leader portion, but still with a delta spot amongst its intermediate spots. AR3217 has also shown activity in the past 24 hours, it's magnetic structure remains difficult to assess due to foreshortening, yet it currently appears to have a beta-gamma configuration. The other regions are generally simpler and more stable, with no current significant growth. There are a total of nine numbered regions on the disc, and one yet to be numbered. A couple of CMEs were observed from the M-flares of AR3217, however these are off the Earth-Sun line, with no Earth-directed CMEs observed.

Solar Wind / Geomagnetic Activity: Solar winds perhaps showed a very weak, glancing CME influence. Observed speeds at L1 fluctuated between 420-530 km/s. The density was generally around average or a little above, after an initial increase around 09/1700 UTC. Total IMF strength, Bt, was mainly weak but became persistently southward directed at around -4nT to -7nT between 09/1700-10/0130 UTC. Phi angle was variable. Geomagnetic activity was Quiet to Unsettled (Kp 2-3), but with Active intervals (Kp 4) between 09/2100-10/0300 UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16 remained at Background levels throughout. The high energy electron flux (greater than 2MeV) measured by GOES-16 was at Moderate to High levels, peaking at 1160pfu at 08/1600 UTC. The associated 24-hour electron fluence was below the Active level reaching 4.23e7 integrated pfu at 10/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity expected with further M-class flares likely from either AR3213 or AR3217. There is a slight chance of X-class flares.

Solar Wind / Geomagnetic Activity: CMEs which left the Sun on the 5th and 7th, while forecast to miss the Earth, give a low chance of glancing interactions on days 1 and 2 (10th and 11th). Otherwise current slightly elevated solar winds are expected to erratically ease, with no other significant enhancements expected. Geomagnetic activity is forecast to be mostly Quiet with Unsettled intervals, but with a chance of Active, and very slight chance of G1 Minor Storms, day 1-2 (10th and 11th) due to any CME arrival that may occur.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at background levels, but with a slight chance of rising in response to any significant flares. High energy (greater than 2 MeV) electron flux is expected to persist at Moderate levels with a chance of High, but with an overall declining trend. There is a slight

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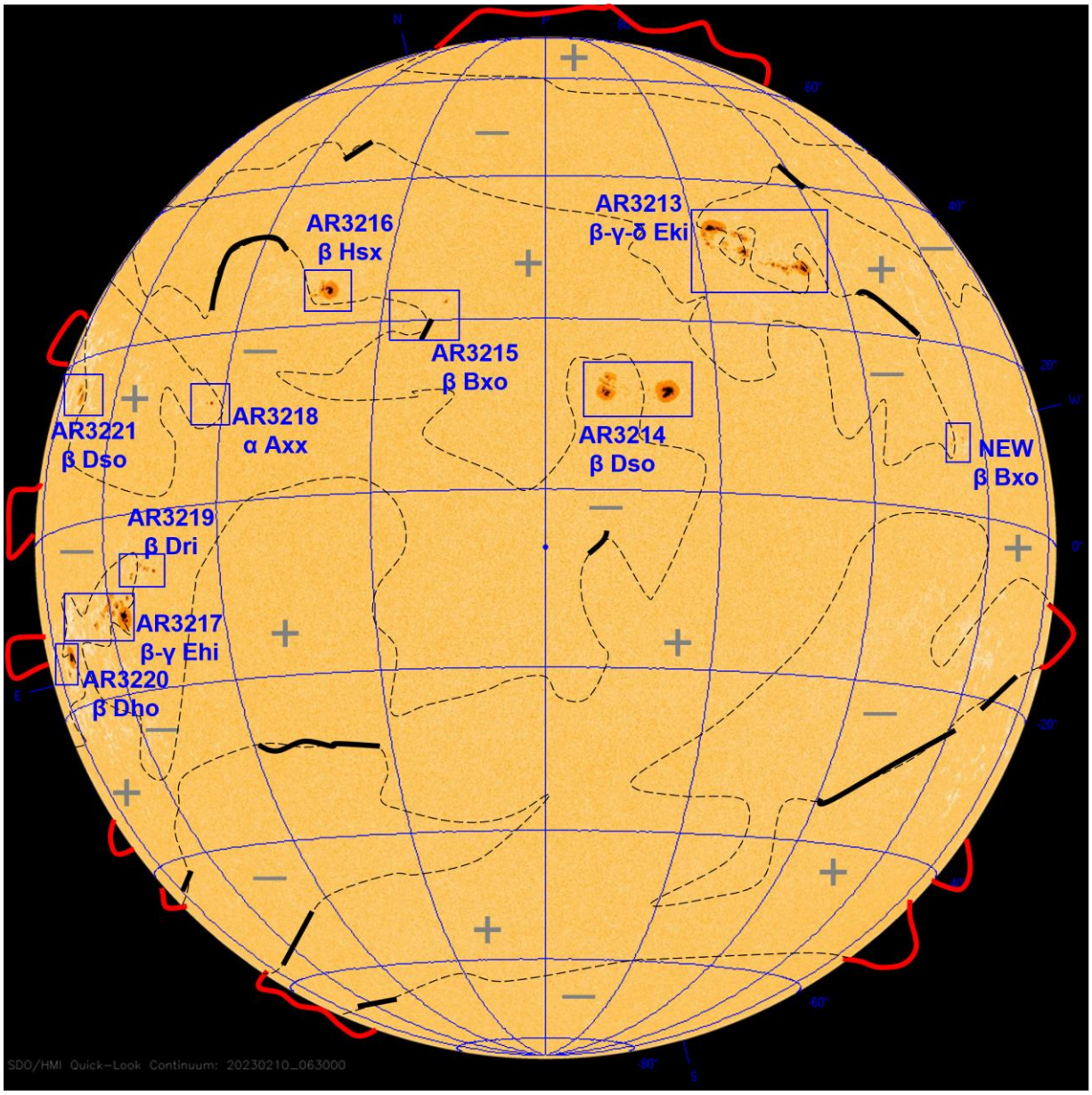
chance of this rising above the Active threshold on day 2 (11th), but likely staying below.

Figure 1. Solar Analysis Valid 10/0630 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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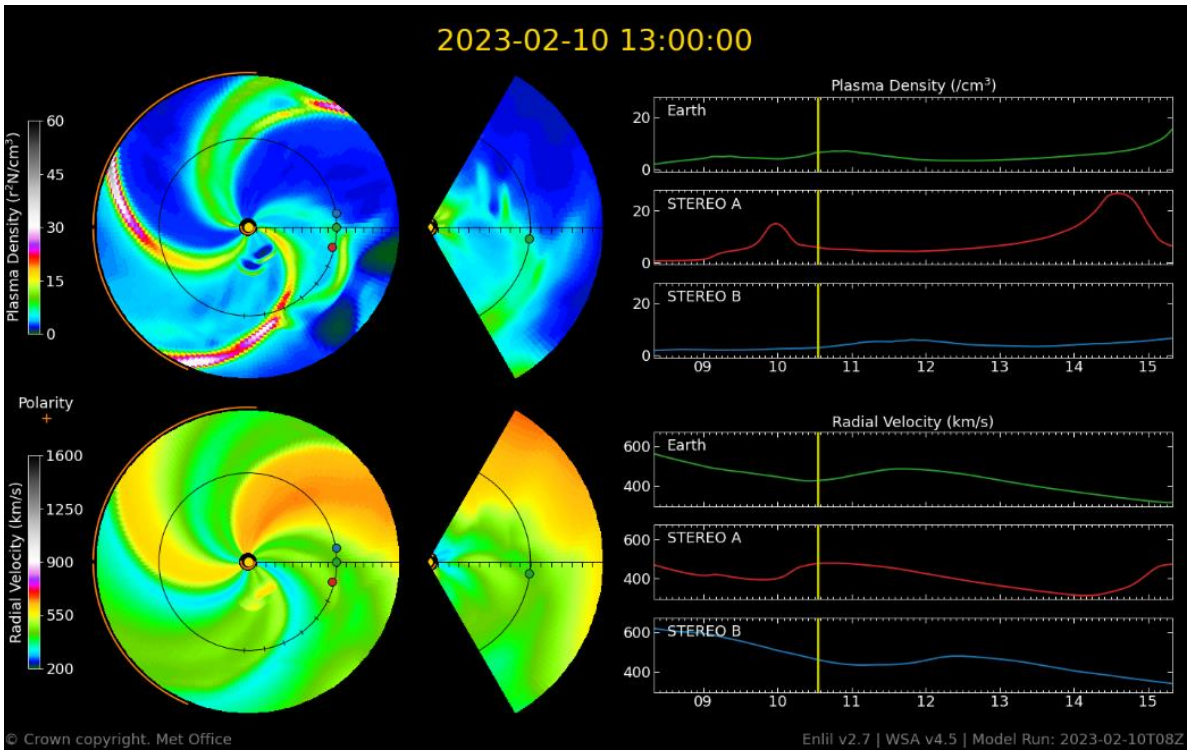
Geomagnetic Storms:

There are a few CMEs currently expected to miss Earth, but passing close enough that glancing impacts cannot be completely ruled out on days 1 and 2 (10th and 11th). This includes a CMEs from a C-flare from AR3213 on the 7th, which is expected to pass north of Earth's orbit on day 2. Otherwise, with evident coronal hole features on the Earth-facing solar disc, the current slightly elevated winds are likely to very gradually ease through the period. This is generally supported by enlil, although this does show a slight increase in wind speeds on day 3 (11th). If any such rise was to occur, it is likely to be relatively weak and unlikely to have a notable impact on the geomagnetic conditions.

Geomagnetic activity is forecast to be mostly Quiet with Unsettled intervals, but with a chance of Active, and very slight chance of G1 Minor Storms, day 1-2 (10th and 11th) due to any CME arrival that may occur.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	5	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: MOSWOC ENLIL



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Radio Blackouts - X-Ray Flares:

Moderate activity is expected to continue through the period, with further M-flares expected, primarily from either of AR3213 Eki/Beta-Gamma-Delta in the northwest quadrant and AR3217 Ehi/Beta-Gamma in the southeast. These also bring a slight chance of X-class flares.

The first of these regions has been the source of multiple M-flares over the last few days, including an M6.3 on the 7th February. This region has a small, but clear delta spot amongst its intermediate spots, and some shear across its polarity inversion line providing additional potential instability. AR3217, while smaller, has been a more active region in the last 2 days, also producing frequent M-flares. Due to its proximity to the limb, some complexity is likely obscured, however it does appear to have an east-west aligned polarity inversion line and some mixed polarity intermediate spots resulting in its beta-gamma configuration. There are a couple of other large regions on the disc, including AR3214 Dso/beta moving into the northwest disc, however these are generally simpler and stable. Far-side products suggest that further regions are likely to rotate onto the northeast disc through the period, however this is low confidence.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	80	70	60	60
Very Active	R3 to R5 X Class	No	15	15	10	10

Figure 3: 24 hour X-Ray trace GOES18

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Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) proton flux as observed by GOES16 is currently at background levels. No notable high energy proton response was observed from the M-class flares so far, however any further significant flares will give a chance of count rates increasing, with a slight chance of reaching the S1 level.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux at GOES-16 is expected to continue Moderate, with a chance of High on day 1 and perhaps day 2 (10th and 11th), but with a gradual declining trend towards background likely through the period. There is also a chance for periods of a more notable dropout in flux to occur on day 1 or day 2, due to any glancing CME influence.

The associated 24 hour fluence is likely to remain below the Active (1e8 integrated pfu) threshold, with a slight chance of rising above this level on day 2 (11th), before a more general decreasing trend is expected. This downward trend is supported by REFM, although the initial peak is too high.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	5	20	10	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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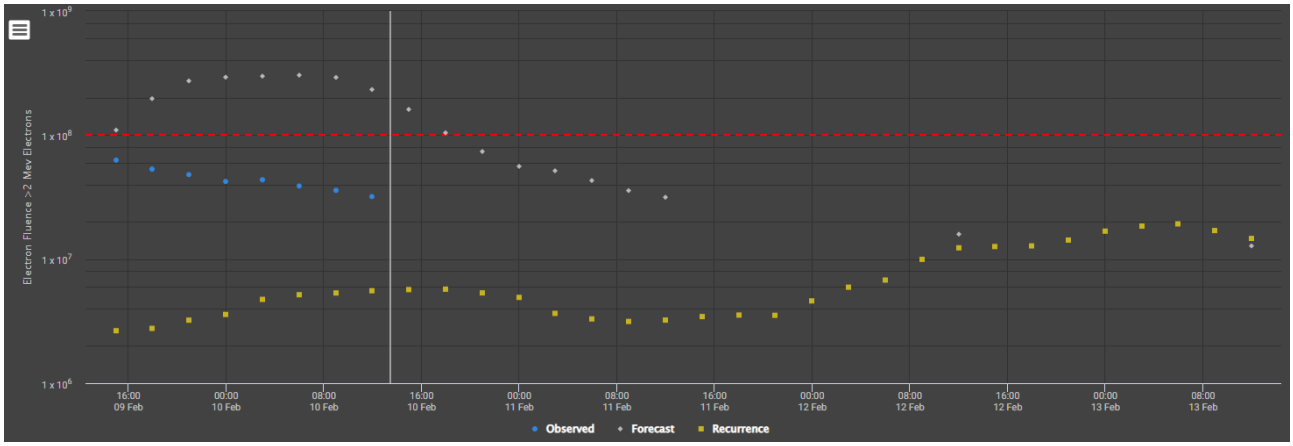
Figure 4: MOSWOC REFM integrated flux/fluence



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